The Universal Genius

Gottfried Wilhelm Leibniz

Universalgenie

"In matters of style, swim with the current; in matters of principle, stand like a rock."

Thomas Jefferson

Introduction

The attempt for this small book was a matter of principle, after reading hundreds of papers and books about this great Philosopher and almost none gave Leibniz an atom of what he deserved based on his Merits.
I even noticed that some books written on Leibniz are very deceiving, it was as if they were captivating all the negatives and laying them in books.
Establishing all their arguments thoughtlessly on some of what Bertrand Russell once said.
What triggered me the most was naming Leibniz's Philosophy a fairy tale, as if they total understood the intricacy of this Mathematical Philosophical Genius.

I can't remember the countless argument I had with book authors about this issue, until one day I was told if you don't like what we write, write your own, so here I am.

C.G. Saliby

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Gottfried Wilhelm Leibniz
(July 1, 1646 – November 14, 1716)

The Word ***Gottfried,*** is of German origin, it consists of the German words for "*Gott* - God" and "*fried* - peace" .

Born on the 1st of July, Leibniz was a German Mathematician, Philosopher, Engineer, Astronomer, Diplomat, Legislator, Theologian and an Eminent Grand Master.

He is considered as one of the most rationalist philosophers and a great sage of the modern world, one of the greatest renaissance men of Western thought and philosophy.
He has made momentous contributions in several fields including mathematics, physics, logic, ethics, law, politics and theology.
A list of his significant contributions is almost as long as the list of his endless accomplishments, his visionary Law of Continuity and The Transcendental Law of Homogeneity only found clear mathematical implementation in the 20th century.
This tells us a great deal why Leibniz wasn't well understood in his early days, and how much ahead of his time he was.

In the Law of Continuity, Leibniz based his work on Cusa & Kepler and took it to a totally different dimension. This principle indicates that " whatever succeeds for the finite also succeeds for the infinite".
Leibniz based on this principle to encompass concepts such as arithmetic operations. Staring from ordinary numbers and reaching to infinitesimals, laying the corner stone work for infinitesimal calculus.

The Transcendental Law of Homogeneity could be described as the principle to the effect that in a sum involving infinitesimals of different orders, only the lowest order term must be retained, and the remainder discarded.
Thus, if $udv + vdu + dudv = udv + vdu$, where the higher order term $dudv$ is discarded in accordance with the Transcendental Law of Homogeneity.

We can clearly say that Leibniz was a champion of the Hyperreal numbers in Mathematics and a Hyper Rationalist in his Philosophy.

As an engineer Leibniz worked on calculating machines, clocks and mining equipment. He also refined the binary number system, which is the foundation of all digital computers and digital technologies of the modern day. In that we can say that Leibniz is the Godfather of the new digital age.

In 1671, Leibniz invented a calculating machine which was a major advance in mechanical calculating. The Leibnizian calculator incorporated a new mechanical feature which is a cylinder bearing nine teeth of different lengths which increase in equal amounts around the drum. This concept invention was the spark of all other inventions in the calculating system machinery field.

As a mathematician, he not only created a revolutionary work in what is now called topology, but came up with the calculus independently of Newton, and his notation has become the standard which is in use today.

As a Philosopher, Leibniz was mostly noted for his optimism and being one of the greatest champions of reason and rationalism. Leibniz concluded that our Universe is the best possible one that a Universal Mind / God could have created.

In the principle of sufficient reason, Leibniz developed a remarkable philosophical system that delivers an intricate and systematic account of reality.
The work of Leibniz projected logic and analytic philosophy, though his philosophy also looks back to the pedagogic tradition, in which conclusions are produced by applying reason to first principles and not empty empirical evidence.

Leibniz believed in an Ontological Mathematical System for all his reasoning and based almost all his principles, thoughts and philosophy on pure logical mathematical rationality.

Leibniz's contributions were scattered in various scientific and academic journals, in tens of thousands of letters, and in unpublished manuscripts. Many of his most important ideas and thoughts are not in the public domain even to this day.
As Leibniz once wrote, 'Anyone who knows me only by my publications does not know me at all'.

He wrote in several languages, but predominantly in Latin, French, and German. His writings are spread on many various subjects such as philosophy, mathematics, politics, law, ethics, theology, history, and philology.

Many of Leibniz ideas and theories were too radical for his time and weren't fully understood till later stages of our modern days.

Leibniz without any shred of a doubt is considered one of the most intelligent human beings ever existed. It's one of the typical absurdities of human history that his name is almost unrecognised today.

Francis Bowen said about Leibniz, "With the single exception of Aristotle, I suppose that Leibniz was the most comprehensive genius that ever lived.

Bertrand Russell wrote, "Leibniz remains a great man, and his greatness is more apparent now than it was at any earlier time. Apart from his eminence as a mathematician and as the inventor of the infinitesimal calculus, he was a pioneer in mathematical logic, of which he perceived the importance when no one else did. And his philosophical hypotheses, though fantastic, are very clear, and capable of precise expression."

It is difficult not to be impressed by the number of ways in which Leibniz's ideas were far ahead of his time. But by him being ahead of his time made him all the less influential. Generally, it has only been after the independent rediscovery of his ideas that his priority has been noticed.
For example, the mathematician and logician, George Boole (1815-64), had first to reinvent the idea of mathematical logic for the chief architects of modern logic Gottlob Frege (1848-1925) and Bertrand Russell (1872-1970) to appreciate that Leibniz was a fellow spirit ... What example was Leibniz setting? His philosophy was largely an updating of the Pythagorean and Platonic traditions, using the concepts of Aristotelian scholasticism. In style and spirit, however, he was

very much a Socrates. He was always in dialogue with others, trying to sympathise with a variety of different points of view, but ready to turn into a philosophical gadfly with professionals, specialists and experts who assumed that they had the whole of the truth on any question. It is easy to advocate following in the Socratic tradition, but few have followed it as successfully as Leibniz."

G Ross.

Leibniz, by Johann Schmidt 1788

The Life of Gottfried Wilhelm Leibniz

Gottfried Wilhelm Leibniz was born in Leipzig, Germany, on the 1st of July, 1646, (towards the end of the Thirty Years War).
The year Descartes died in 1650, the young Leibniz was 4 years old watching the Swedish soldieries evacuating his city as dictated by the Peace of Westphalia. This treaty indicated for France and its Swedish allies to leave German soil and end their occupation on Leipzig.

"The Thirty Years War is considered one of the longest continuous wars in modern history. It was mainly fought as a religious war between Protestants and Catholics in the Holy Roman Empire, with two major players the Bourdon of France and the Habsburg of Austrian origin.
This war almost brought Europe on its knees with famine and diseases spread all over the continent. Most of the countries participating in that war were bankrupt with a significantly decreased in their populations."

His father was a professor of moral philosophy named Friedrich Leibniz and his mother Catharina Schmuck was the daughter of a famous Leipzig Lawyer.

Leibniz studied at the Nicolai school at Leipzig. But, from 1652 when his father died, seems Leibniz have been for the most part his own teacher. Captivated with the mystery of mathematics and its hidden allegories, Leibniz grew to be the master of deciphering its numerical secrets.

Leibniz mastered the art of combinatorics "Combinations"; he could disassemble and re-combine letters to form words of a stunning number of variations with an amazing speed.

Nicolai

With the death of his father, Leibniz inherited his library in which he had free access to it from the age of seven. While Leibniz's school work focused on a small canon of authorities, his father's library enabled him to study a wide variety of advanced philosophical and theological works.
Since most of the academic books of his father's library were in Latin. As Latin was the language of academia in these days, Leibniz was proficient in Latin by the age of 12.

At the age of fifteen, Leibniz was admitted to the University of Leipzig as a law student. At Leipzig University Leibniz meet Jakob Thomasius (1622–1684). Thomasius was a professor of Rhetoric and Moral Philosophy and has been described as Leibniz's mentor at his early years.
Thomasius produced great philosophical work such as;

Schediasma historicum, Dissertationes ad stoicae philosophiae and Orationes.

Leipzig University

In the summer of 1663, Leibniz studied at Jena University under Erhard Weigel (1625 – 1699).
Weigel himself a student of Leibniz University was a professor of mathematics at Jena University from 1653 and until his death. Weigel could be easily considered the forefather of many great Mathematicians and Logicians. His work included *Speculum Temporis Civilis, Speculum Terrae and Idea Matheseos Universae cum Speciminibus Inventionum Mathematicarum.* His work ***the mystery of Holy Trinity demonstrated from the principle of geometry*** brought him in major conflict with the Church authority in these days and was forced to retract all his work.

Weigel

Leibniz completed his baccalaureate thesis "bachelor's degree" in philosophy. He defended his De Principio Individui "On the Principle of the Individual", which defend the nominalistic doctrine that individuality is constituted by the whole entity or essence of a thing. Leibniz earned his master's degree in philosophy on February 7, 1664.

He published and defended a dissertation "Specimen Quaestionum Philosophicarum ex Jure collectarum", arguing for both a theoretical and a pedagogical relationship between philosophy and law. After one year of legal studies, he was awarded his bachelor's degree in Law on September 28, 1665.

In 1666, at the age of 20, Leibniz published his first book, *De Arte Combinatoria* "On the Art of Combination", an essay towards his lifelong project of a reformed symbolism and method of thought.
When it was published and circulated, Leibniz regretted it, as he considered it an undeveloped work and not completed to his perfection standards. Nevertheless it was an original work and it provided him an early glimpse of fame among the academics of his time.

In 1666, Leibniz left the University of Leipzig and enrolled in the University of Altdorf, he submitted a thesis "Disputatio Inauguralis De Casibus Perplexi In Jure " which he already wrote while he was at Leipzig.

Leibniz earned his license to practice law and his Doctorate in Law. He declined the offer of an academic appointment at Altdorf University, since he had his eyes set on a total different path.

The years 1667 and 1668 were of significant importance in the life of Leibniz. He was part of many secret societies in Nuremberg.
During this time Nuremberg was a centre of the Rosicrucians movement which was the face for other secret societies, Leibniz who was very interested in alchemy soon gained such knowledge of their inner doctrines. He swiftly moved up the ranks and was admitted to its inner secret brotherhood, which he was elected as its Grand Master later on.

Many wrote that it was the Rosicrucian that Leibniz was involved with, but it wasn't the Rosicrucian or the Freemason that he became a prominent figure in.
In this time also, Leibniz wrote one of his most important essay in law, *Nova methodus docendi discendique juris in which Leibniz presented to* the Elector of Mainz Johann Philipp von Schönborn himself. *This essay was* written in the intervals of his journey from Leipzig to Altdorf. What makes it remarkable, not only for the reconstruction it attempted of the *Corpus Juris* "body of law", but as containing the first clear recognition of the importance of the historical method in law.

In 1668, shortly after receiving his doctoral degree in law Leibniz accepted employment as lawyer, librarian, and foreign affairs advisor to Johann Christian Freiherr von Boyneburg (1622-1672), and the Elector of Mainz, Johann Philipp von Schönborn.

Johann Christian Freiherr Von Boyneburg was a highly educated person, and one of the most distinguished German statesmen of the day who worked for a balance of power between the Habsburg emperor and the other German princes and for a solution of the Roman Catholic -Lutheran on going conflict.

The Elector who was very impressed with Leibniz ingenuity and talents asked Leibniz to assist with the redrafting of the legal code for his Electorate. In 1669, Leibniz was appointed Assessor in the Court of Appeal.

Leibniz's service to the Elector soon followed a diplomatic role. He published an essay, under the pseudonym of a fictitious nobleman, arguing for the German candidate for the Polish crown. The main force in European geopolitics during Leibniz's life was the ambition of Louis XIV of France, which the Thirty Years War didn't seem to change any of his political ambitions.

This same war had left German exhausted and fragmented with

a weak economy. This brought Leibniz to propose on ways to protect German from the determined Louis by distracting him into other battles further from Europe.
Leibniz proposed that, France would be invited to take Egypt as a stepping stone towards an eventual conquest of the Dutch East Indies. In return, France would agree to leave Germany and the Netherlands undisturbed. This plan obtained the Elector' s cautious support, and Leibniz was asked to set the scene for this plan to take place.

In 1672, the French government invited Leibniz to Paris for discussion, but the plan was soon overtaken by the outbreak of the Franco-Dutch War.
While Leibniz was in Paris waiting to carry out his political objectives, he was introduced to a wide range of contacts, including the philosophers Malebranche, and the mathematician Huygens.

Using his new contacts, he managed to get access to the unpublished writings of many important French Philosophers like Pascal and Descartes.

During this year Leibniz managed to have access to many of Descartes unpublished work, like the ' Calcul de Monsieur Des Cartes' and ' Cartesii opera philosophyica".

These unpublished works of Descartes, made Leibniz ask for

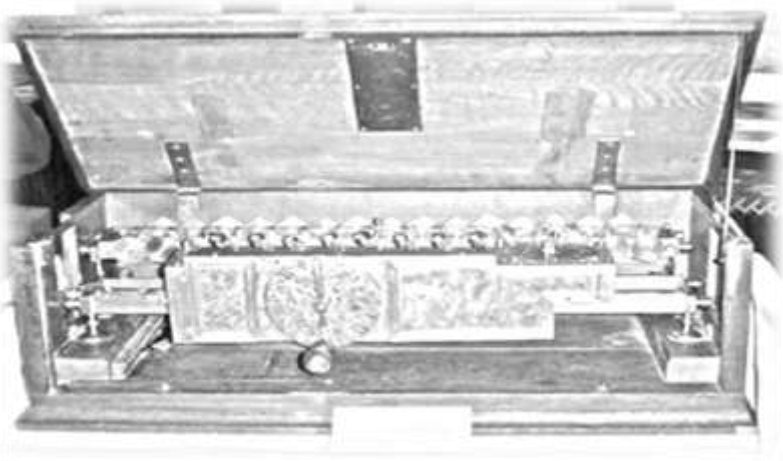
more and he did get it.

Leibniz stay in Paris was very productive and fruitful, many of his inventions and mathematical principles saw light at this stage of his career.

One of his many inventions was a device for calculating a ships position without using a compass or observing the stars, another was a mechanical air compressed engine for propelling vehicles and an early design of a submarine which Leibniz envisioned it as a ship that goes under waters.

When it became clear that France would not implement its part of Leibniz's Egyptian plan, the Elector sent Leibniz, on a related mission to the English Government in London, early in 1673.

There Leibniz met with the Royal Society where he demonstrated a calculating machine that he had designed. The machine was able to execute all four basic operations (subtracting, adding, multiplying, and dividing). This calculating machine was a major advance in mechanical calculating and a stepping stone for further inventions.



In 1673 and after the death of Elector of Mainz, the Duke of Brunswick offered Leibniz the post of Court Counsellor which Leibniz accepted.
Leaving Paris he took the opportunity to travel through London and Holland, where he spent a month visiting Spinoza in Amsterdam. During that time Spinoza had just completed his masterwork, the Ethics. It was very clear the respect Leibniz had for Spinoza's intellect and thoughts, which didn't stop Leibniz from criticising some of Spinoza's ideas.

He also took on diverse projects, including one that involved the draining of water from the mines in the Harz Mountains. He proposed to use wind and water power to operate pumps. Though the project failed, his time on the project led to

important discoveries in the field of geography and what will be called topology, including the theory that the earth was once molten. During these years he also developed a binary number system, as well as a series of key components to a discipline of symbolic logic. He also returned his focus on his own philosophy, completing works on metaphysics and systematic philosophy.

Leibniz began working on the calculus in 1674, the earliest evidence of its use in his surviving notebooks. By 1677 he had perfected his system, but did not publish it until 1684.
Leibniz was falsie accused by Newton stealing his calculus work. Hence, Leibniz calculus differs from Newton in many ways and was much more logical and easier which made it more popular than of Newtons.

Leibniz's most important mathematical papers were published between 1682 and 1692, usually in a journal which he and Otto Mencke founded in 1682, the Acta Eruditorum "Reports of the scholars".
Since its foundation many eminent scientists published their work in, such as Jakob Bernoulli, Humphry Ditton, Leonhard Euler and Pierre-Simon Laplace.
That journal played a key role in advancing his mathematical and scientific reputation, which in turn enhanced his eminence in diplomacy, history, theology, and philosophy.

In 1677, he was promoted to Privy Counsellor of Justice, a post he held for the rest of his life. Leibniz served three consecutive rulers of the House of Brunswick as historian, political adviser, and most consequentially, as librarian.

In the 1689, the Bill of Rights was introduced which excluded Catholics from the throne of England. This Bill made it almost inevitable that the succession would pass through Elizabeth of Bohemia and hence to Sophie **(1630-1714)** *"who was Leibniz's philosophical confidante"* and her eldest son Georg Ludwig, once both King William III and his sister-in-law and successor Queen Anne were dead.

Sophie of Hanover

The presumption was eventually enshrined in the Act of Succession of 1701, but both before and after the passing of the Act, there were delicate negotiations between London and Hanover. In which Leibniz played an important role in these discussions.

In 1708, John Keill, writing in the journal of the Royal Society with Newton's blessing, accused Leibniz of having plagiarized Newton's calculus. A formal investigation by the Royal Society, (which Newton was its most eminent member) undertaken in response to Leibniz's demand for a retraction, supporting Keill's charge.

One of the most remarkable aspects of this futile brawl was that no participant doubted for a moment that Newton had already developed his method of fluxions when Leibniz began working on the differential calculus. Yet there was seemingly no proof beyond Newton's word.
At the end of the day, it wasn't Newton or Leibniz who started this quarrel but the people in their circles. And if it was left to both of them alone, nothing of that would have happened. Taking in account their level of intelligence and the noble characters both had.

Years Later, Leibniz explained his silence in a letter to Conti dated 9 April 1716 as follows:

In order to respond point by point to all the work published against me, I would have to go into much minutiae that occurred thirty, forty years ago, of which I remember little: I would have to search my old letters, of which many are lost. Moreover, in most cases I did not keep a copy, and when I did, the copy is buried in a great heap of papers, which I could sort through only with time and patience. I have enjoyed little leisure, being so weighted down of late with occupations of a totally different nature.

While Leibniz's death put a temporary stop to the controversy, the debate persisted for many years. Mathematic Historians writings have tended to acquit Leibniz, pointing important differences between Leibniz's and Newton's versions of the calculus.

During the 1711, Leibniz met the Russian Tsar Peter the Great couple of times. Leibniz presented the Tsar a memoir consisting of plans on education and the proposed plan of what would eventually be the Saint Petersburg Academy of Science. Also Leibniz discussed plans on sending an expedition to investigate the border between Asia and North America. Leibniz suggested also that the Tsar should initiate communication with China for the purpose of learning the sciences and arts known in the East but not in Europe at that time.

In 1712, Leibniz began a two-year residence in Vienna, where he was appointed Imperial Court Councillor to the Habsburgs. On the death of Queen Anne in 1714, Elector George Louis became King George I of Great Britain, under the terms of the 1701 Act of Settlement. Even though Leibniz had done much to bring about this event, but Georges I wasn't as truthful as Leibniz thought.
Georges I still disputed the fact that Leibniz didn't published any work on the Brunswick family, and Leibniz on the other hand and after seen as having won the calculus priority dispute

didn't think much of that petit project worth any of his time. So standing in British official circles wasn't of any interest for Leibniz at that time.

Leibniz at Sophie Hanover court

Leibniz Death

Leibniz died in Hanover at the age of 70 on the 14th of November 1716 at 10 pm. Only few of his personal assistants attended his funeral.
Neither at Berlin, in the Academy of Sciences which he had founded, nor in London, where his sovereign and life time membership was any notice taken of his death.
Both Societies didn't honour his death as they should and that will be a black stain on both societies history.
Leibniz was buried near the ducal palace in the Neustädter Kirche. For more than 50 years his unmarked grave was neglected.
Not until 1790, a large sandstone marker was set in place bearing the simple inscription, "Ossa Leibnitii "

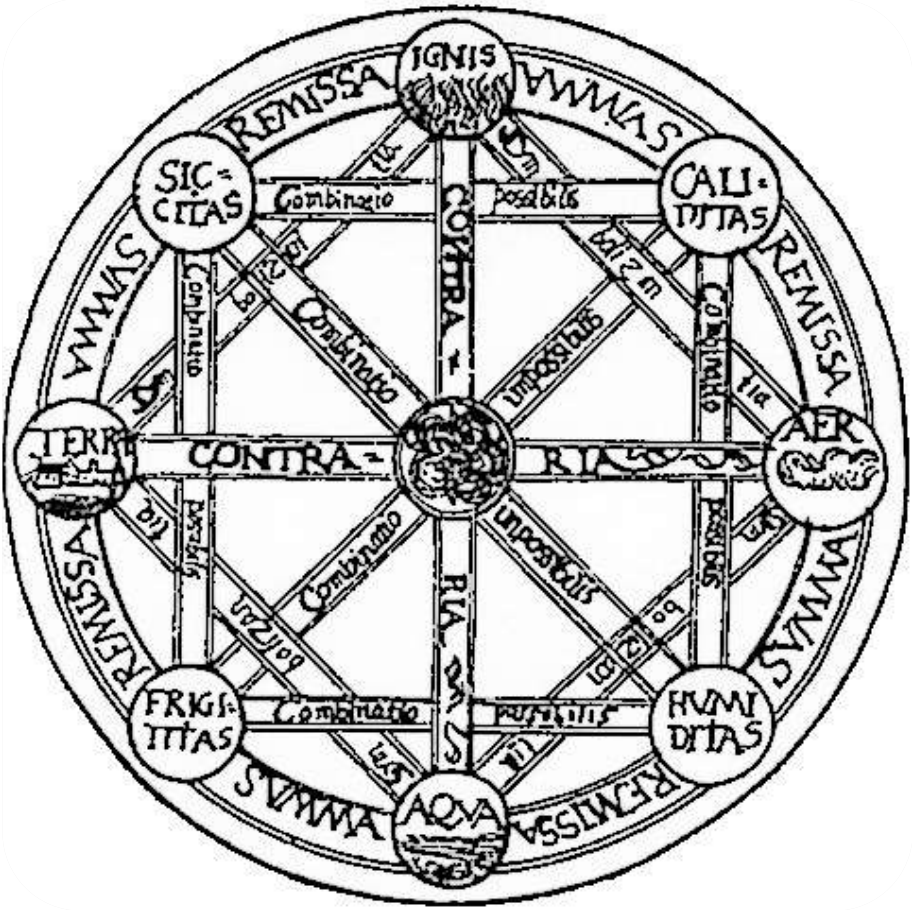

OSSA
LEIBNITII

Leibniz Work

Leibniz was perhaps the most hard working philosopher and mathematician in his days; he produced a huge number of essays, papers and correspondences. Very little was published in his life time and much is still unpublished to this day.

His most important work in Philosophy is perhaps the following.

I. Discours de metaphysique, written in 1685.
II. The Famous Correspondence with Arnauld, written in 1686.
III. The New System, published in Journal des Savans, written in 1695.
IV. Controversy with Pierre Bayle, written in 1698.
V. Letters to John Bernoulli, written in 1698.
VI. Letters to Volder, written in 1699.
VII. Letters to des Bosses, written in 1706-15.
VIII. Theodicy, one of his most popular works. Published in his Lifetime in 1710.
IX. Principle of Nature and of Grace, written in 1712 and published in 1718.
X. Monadology, written between 1712 and 1714 and published in 1720.
XI. Correspondence with Clarke, written in 1715-16.


IGNIS
REMISSA
SUMMAS
SIC-
CITAS
CALI-
TITAS
Combinatio
possibilis
CONTRA-
SUMMA
REMISSA
TERRA
AER
RIA
impossibilis
FRIGI-
TITAS
HUMI-
DITAS
AQUA

Leibniz the Philosopher

Leibniz did not write a *magnum opus*, there is no single work that can be said to contain the core of his thought at least not in the public domain. But he did produce many essays, some that were published in scholarly journals mostly the Acta Eruditorum.

One of the most important aspects of Leibniz's philosophy was his vision of a universal encyclopaedia, which would integrate all knowledge into one single system. Many of his activities were envisioned as contributions towards this enduring objective.

Many of Leibniz's writings, essays and correspondent letters have not yet been published. The authoritative scholarly version of Leibniz' s works has thus far only published his philosophical writings from 1663 to 1690.
This implies that only half of his writing life has been covered. And the sheer act of dating pieces often depends upon careful analysis of the paper Leibniz wrote on and watermarks and so on.

These contributing factors made it hard to piece Leibniz's philosophy together into a systematic whole because Leibniz seems refined his views on a number of issues over the course of his career.

Leibniz had many reservations about assured facets of the modern philosophy. There are clear traces of Platonic and Aristotelian thoughts in Leibniz philosophical thinking.

Some might even consider that Leibniz's philosophy was a reaction to two sets of modern opponents. On one hand there is Descartes and on the other there is Spinoza.

Leibniz had a love-hate relationship for both Descartes and Spinoza intellectual ideas and philosophies.
As Bernard Russell puts it, Leibniz thinking was formed in the scholastic tradition, and he was steeped in Aristotelian scholastic ideas about the universe. He broke away from this philosophy only through work in mathematics later in his life.

Leibniz's criticism of Descartes was on his ideas on the new mechanical philosophy, which focused mainly on the corporeal substance. Descartes says that, the essence of body is a corporeal substance which is simply a geometric object made concrete, an object that has shape in motion.
Leibniz criticised the corner stone of the Cartesian philosophy, when he declared that the principle of doubt was a flaw.

Some of Leibnizian Principles and Theories

1- Principle of Sufficient Reason. "Nothing is without a reason; there is no effect without a cause."

2- Principle of Contradiction/Identity. If a proposition is true, then its negation is false and vice versa.

3- Principle of Identity of indiscernibles. Two distinct things cannot have all their properties in common. If every predicate possessed by x is also possessed by y and vice versa, then entities x and y are identical; to suppose two things indiscernible is to suppose the same thing under two names. This is sometimes referred to as Leibniz' s Law.

4- Theory of Pre-established harmony. " The appropriate nature of each substance brings it about that what happens to one corresponds to what happens to all the others, without, however, their acting upon one another directly." (Discourse on Metaphysics, XIV)

5- Principle of Law of Continuity. ***Natura non saltum facit.*** "Nature does not make jumps".

6- *Principle of Optimism. "We live in the best of all possible worlds, or that God created a physical universe that applies the laws of physics."*

7- *Principle of Plenitude. Affirms that the actual world, considered as a set of monads, is as full as it can possibly be. Leibniz clearly maintained that every genuine possibility must be actualized in the best of all possible worlds.*

A brief explanation on some of the Leibnizian Principles:

Principle of Sufficient Reason
Principle of Contradiction
Principle of the Identity of Indiscernible
Theory of Pre-established harmony
Principle of Law of Continuity
Principle of Optimism
Principle of Plenitude

Principle of Sufficient Reason

nihil est sine ratione "nothing is without a reason".

The Principle of Sufficient Reason indicates that *there is no effect without a cause;* his principle must be considered one of the greatest of all human knowledge, for upon it is built a great part of metaphysics and physics.
Nothing takes place without a sufficient reason means that nothing happens in a way that it is impossible for someone with to apply reason to it and why it is so and not otherwise.

..he who completed the whole demonstration would then show that it was rational and therefore definite that this would

happen, but not that it is necessary in itself, or that the contrary implies a contradiction. "Discourse on Metaphysics"

Principle of Contradiction

It is impossible that two contradictory propositions be true, for any proposition p, p is either true or false and cannot be both at the same time.
Each substance may individually be possible, but they must all be possible together, the universe forming a vast, consistent, non-contradictory system.

Principle of the Identity of Indiscernible or Leibniz Law

Necessarily, for anything, x, and anything, y, x is identical to y ***if and only if*** *for any property x has, y has, and for any property y has, x has. Because this is a bi-conditional, it is comprised of two conditional statements (a) and (b).*

a. If x is identical to y, then for any property x has, y has and for any property y has, x has.
b. If for any property x has, y has, and for any property y has, x has, and then x is identical to y.

Theory of Pre-established harmony

The Theory of pre-established harmony is a philosophical theory about causation under which every material affects itself, but all the materials or substances in the world seems to causally interact with each other because they have been programmed in advance to do so. In other word they are in harmony with each other. What Leibniz was trying to describe was the " monads".

Principle of Law of Continuity

In Leibniz Words, "In any supposed continuous transition, ending in any terminus, it is permissible to institute a general reasoning, in which the final terminus may also be included." The Principle of Law of Continuity was introduced by Leibniz based on earlier work by Cusa and Kepler. It is the principle that says: "Whatever succeeds for the finite also succeeds for the infinite".

Leibniz used this principle to extend concepts such as arithmetic operations, from ordinary numbers to infinitesimals, laying the groundwork for his famous infinitesimal calculus. A mathematical implementation of the law of continuity is provided by the transfer principle in the context of the Hyperreal numbers.

Principle of Optimism

The best of all possible worlds; " Die beste aller möglichen Welten" .
In his book Theodicy which means God Justice in Greek, Leibniz claims that the actual world is the best of all possible worlds. In which he attempt to solve the problem of evil in response to Pierre Bayle. Bayle, a Protestant philosopher argued in his work "Dictionnaire Historique et Critique", that because the Bible asserts the coexistence of God and Devil or "good and evil", this state of affairs must simply be accepted.

Principle of Plenitude / Plenum

This Principle is traced back to Aristotle, who said that no possibilities which remain eternally possible will go unrealized. For Leibniz as he clearly maintained that every genuine possibility must be actualized in the best of all possible worlds, It is simply that everything that can be, *is*.
According to this Principle, this actual world, considered as a set of monads, is as full as it can possibly be. Since there is no genuine interaction among distinct substances, there would be no sufficient reason for the non-existence of any monad that would be consistent with the others within a possible world. Hence, anything that can happen will; every possibility within this world must be actualized. The world in which we live is but one

among the infinitely many possible worlds that might have existed.

The Monads

Leibniz' s best known contribution to metaphysics is his theory of monads, as exposited in Monadology.
It has been said that Leibniz produced two versions of the Monadology, the published one which is the one in the public domain and an unpublished version in which is said that he explained all his thoughts freely in.
Leibniz was the ultimate rationalist Philosopher; he strongly held that the whole of existence could be calculated from "fix principles". If the universe was organised according to coherent principles, then it is just a matter of knowing which principles they are. Reason and not our senses is the means for unlocking the greatest secrets of our universe.

Monads are the ultimate elements of the universe. The monads are " substantial forms of being" with the following properties: they are eternal, indecomposable, individual, subject to their own laws, un-interacting, and each reflecting the entire universe in a pre-established harmony. Monads are centres of force; substance is force, while space, matter, and motion are merely phenomenal.

The ontological essence of a monad is its irreducible simplicity. Monads possess no material or spatial character. They are complete mutual independent, so that interactions among monads are only apparent. Instead, by virtue of the principle of pre-

established harmony, each monad follows a preprogramed set of " instructions" a mathematical set of rules.
Each monad is like a little mirror of the universe. God is a monad, and the existence of God can be inferred from the harmony prevailing among all other monads.

The ultimate reason of all things must be found in a necessary and universal substance, which is God. A primary substance is dimensionless. Every monad is produced from a primary unity, which is God. Every monad is eternal, and contributes to the unity of all the other monads in the universe.

THE MONADOLOGY

By Gottfried Wilhelm Leibniz
Translated by Robert Latta - 1898

1. The Monad, of which we shall here speak, is nothing but a simple substance, which enters into compounds. By 'simple' is meant 'without parts.' (Theod. 10.)

2. And there must be simple substances, since there are compounds; for a compound is nothing but a collection or aggregatum of simple things.

3. Now where there are no parts, there can be neither extension nor form [figure] nor divisibility. These Monads are the real atoms of nature and, in a word, the elements of things.

4. No dissolution of these elements need be feared, and there is no conceivable way in which a simple substance can be destroyed by natural means. (Theod. 89.)

5. For the same reason there is no conceivable way in which a simple substance can come into being by natural means, since it cannot be formed by the combination of parts [composition] .

6. Thus it may be said that a Monad can only come into being or come to an end all at once; that is to say, it can come into being only by creation and come to an end only by annihilation, while that which is compound comes into being or comes to an end by parts.

7. Further, there is no way of explaining how a Monad can be altered in quality or internally changed by any other created thing; since it is impossible to change the place of anything in it or to conceive in it any internal motion which could be produced, directed, increased or diminished therein, although all this is possible in the case of compounds, in which there are changes among the parts. The Monads have no windows, through which anything could come in or go out. Accidents cannot separate themselves from substances nor go about outside of them, as the 'sensible species' of the Scholastics used to do. Thus neither substance nor accident can come into a Monad from outside.

8. Yet the Monads must have some qualities, otherwise they would not even be existing things. And if simple substances did not differ in quality, there would be absolutely no means of perceiving any change in things. For what is in the compound can come only from the simple elements it contains, and the Monads, if they had no qualities, would be indistinguishable from one another, since they do not differ in quantity. Consequently, space being a plenum, each part of space would always receive, in any motion, exactly the equivalent of what it

already had, and no one state of things would be discernible from another.

9. Indeed, each Monad must be different from every other. For in nature there are never two beings which are perfectly alike and in which it is not possible to find an internal difference, or at least a difference founded upon an intrinsic quality [dénomination] .

10. I assume also as admitted that every created being, and consequently the created Monad, is subject to change, and further that this change is continuous in each.

11. It follows from what has just been said, that the natural changes of the Monads come from an internal principle, since an external cause can have no influence upon their inner being. (Theod. 396, 400.)

12. But, besides the principle of the change, there must be a particular series of changes [un détail de ce qui change] , which constitutes, so to speak, the specific nature and variety of the simple substances.

13. This particular series of changes should involve a multiplicity in the unit [unité] or in that which is simple. For, as every natural change takes place gradually, something changes and something remains unchanged; and consequently a simple substance must be affected and related in many ways, although it has no parts.

14. The passing condition, which involves and represents a multiplicity in the unit [unite] or in the simple substance, is nothing but what is called Perception, which is to be distinguished from Apperception or Consciousness, as will afterwards appear. In this matter the Cartesian view is extremely defective, for it treats as non-existent those perceptions of which we are not consciously aware. This has also led them to believe that minds [esprits] alone are Monads, and that there are no souls of animals or other Entelechies. Thus, like the crowd, they have failed to distinguish between a prolonged unconsciousness and absolute death, which has made them fall again into the Scholastic prejudice of souls entirely separate [from bodies] , and has even confirmed ill-balanced minds in the opinion that souls are mortal.

15. The activity of the internal principle which produces change or passage from one perception to another may be called Appetition. It is true that desire [l'appetit] cannot always fully attain to the whole perception at which it aims, but it always obtains some of it and attains to new perceptions.

16. We have in ourselves experience of a multiplicity in simple substance, when we find that the least thought of which we are conscious involves variety in its object. Thus all those who admit that the soul is a simple substance should admit this multiplicity in the Monad; and M. Bayle ought not to have found any

difficulty in this, as he has done in his Dictionary, article 'Rorarius.'

17. Moreover, it must be confessed that perception and that which depends upon it are inexplicable on mechanical grounds, that is to say, by means of figures and motions. And supposing there was a machine, so constructed as to think, feel, and have perception, it might be conceived as increased in size, while keeping the same proportions, so that one might go into it as into a mill. That being so, we should, on examining its interior, find only parts which work one upon another, and never anything by which to explain a perception. Thus it is in a simple substance, and not in a compound or in a machine that perception must be sought for. Further, nothing but this (namely, perceptions and their changes) can be found in a simple substance. It is also in this alone that all the internal activities of simple substances can consist. (Theod. Pref. [E. 474; G. vi. 37] .)

18. All simple substances or created Monads might be called Entelechies, for they have in them certain perfection (echousi to enteles); they have certain self-sufficiency (autarkeia) which makes them the sources of their internal activities and, so to speak, incorporeal automata. (Theod. 87.)

19. If we are to give the name of Soul to everything which has perceptions and desires [appetits] in the general sense which I have explained, then all simple substances or created Monads

might be called souls; but as feeling [le sentiment] is something more than a bare perception, I think it right that the general name of Monads or Entelechies should suffice for simple substances which have perception only, and that the name of Souls should be given only to those in which perception is more distinct, and is accompanied by memory.

20. For we experience in ourselves a condition in which we remember nothing and have no distinguishable perception; as when we fall into a swoon or when we are overcome with a profound dreamless sleep. In this state the soul does not perceptibly differ from a bare Monad; but as this state is not lasting, and the soul comes out of it, the soul is something more than a bare Monad. (Theod. 64.)

21. And it does not follow that in this state the simple substance is without any perception. That, indeed, cannot be, for the reasons already given; for it cannot perish, and it cannot continue to exist without being affected in some way, and this affection is nothing but its perception. But when there is a great multitude of little perceptions, in which there is nothing distinct, one is stunned; as when one turns continuously round in the same way several times in succession, whence comes a giddiness which may make us swoon, and which keeps us from distinguishing anything. Death can for a time put animals into this condition.

22. And as every present state of a simple substance is naturally a consequence of its preceding state, in such a way that its present is big with its future; (Theod. 350.)

23. And as, on waking from stupor, we are conscious of our perceptions, we must have had perceptions immediately before we awoke, although we were not at all conscious of them; for one perception can in a natural way come only from another perception, as a motion can in a natural way come only from a motion. (Theod. 401-403.)

24. It thus appears that if we had in our perceptions nothing marked and, so to speak, striking and highly-flavoured, we should always be in a state of stupor. And this is the state in which the bare Monads are.

25. We see also that nature has given heightened perceptions to animals, from the care she has taken to provide them with organs, which collect numerous rays of light, or numerous undulations of the air, in order, by uniting them, to make them have greater effect. Something similar to this takes place in smell, in taste and in touch, and perhaps in a number of other senses, which are unknown to us. And I will explain presently how that which takes place in the soul represents what happens in the bodily organs.

26. Memory provides the soul with a kind of consecutiveness, which resembles [imite] reason, but which is to be

distinguished from it. Thus we see that when animals have a perception of something which strikes them and of which they have formerly had a similar perception, they are led, by means of representation in their memory, to expect what was combined with the thing in this previous perception, and they come to have feelings similar to those they had on the former occasion. For instance, when a stick is shown to dogs, they remember the pain it has caused them, and howl and run away. (Theod. Discours de la Conformite, &c., ss. 65.)

27. And the strength of the mental image which impresses and moves them comes either from the magnitude or the number of the preceding perceptions. For often a strong impression produces all at once the same effect as a long-formed habit, or as many and oft-repeated ordinary perceptions.

28. In so far as the concatenation of their perceptions is due to the principle of memory alone, men act like the lower animals, resembling the empirical physicians, whose methods are those of mere practice without theory. Indeed, in three-fourths of our actions we are nothing but empirics. For instance, when we expect that there will be daylight to-morrow, we do so empirically, because it has always so happened until now. It is only the astronomer who thinks it on rational grounds.

29. But it is the knowledge of necessary and eternal truths that distinguishes us from the mere animals and gives us Reason and the sciences, raising us to the knowledge of ourselves and of God.

And it is this in us that is called the rational soul or mind [esprit] .

30. It is also through the knowledge of necessary truths, and through their abstract expression, that we rise to acts of reflexion, which make us think of what is called I, and observe that this or that is within us: and thus, thinking of ourselves, we think of being, of substance, of the simple and the compound, of the immaterial, and of God Himself, conceiving that what is limited in us is in Him without limits. And these acts of reflexion furnish the chief objects of our reasoning's. (Theod. Pref. [E. 469; G. vi. 27] .)

31. Our reasoning's are grounded upon two great principles, that of contradiction, in virtue of which we judge false that which involves a contradiction, and true that which is opposed or contradictory to the false; (Theod. 44, 169.)

32. And that of sufficient reason, in virtue of which we hold that there can be no fact real or existing, no statement true, unless there be a sufficient reason, why it should be so and not otherwise, although these reasons usually cannot be known by us. (Theod. 44, 196.)

33. There are also two kinds of truths, those of reasoning and those of fact. Truths of reasoning are necessary and their opposite is impossible: truths of fact are contingent and their opposite is possible. When a truth is necessary, its reason can be

found by analysis, resolving it into more simple ideas and truths, until we come to those which are primary. (Theod. 170, 174, 189, 280-282, 367. Abrege, Object. 3.)

34. It is thus that in Mathematics speculative Theorems and practical Canons are reduced by analysis to Definitions, Axioms and Postulates.

35. In short, there are simple ideas, of which no definition can be given; there are also axioms and postulates, in a word, primary principles, which cannot be proved, and indeed have no need of proof; and these are identical propositions, whose opposite involves an express contradiction. (Theod. 36, 37, 44, 45, 49, 52, 121-122, 337, 340-344.)

36. But there must also be a sufficient reason for contingent truths or truths of fact, that is to say, for the sequence or connexion of the things which are dispersed throughout the universe of created beings, in which the analysing into particular reasons might go on into endless detail, because of the immense variety of things in nature and the infinite division of bodies. There is an infinity of present and past forms and motions which go to make up the efficient cause of my present writing; and there is an infinity of minute tendencies and dispositions of my soul, which go to make its final cause.

37. And as all this detail again involves other prior or more detailed contingent things, each of which still needs a similar

analysis to yield its reason, we are no further forward: and the sufficient or final reason must be outside of the sequence or series of particular contingent things, however infinite this series may be.

38. Thus the final reason of things must be in a necessary substance, in which the variety of particular changes exists only eminently, as in its source; and this substance we call God. (Theod. 7.)

39. Now as this substance is a sufficient reason of all this variety of particulars, which are also connected together throughout; there is only one God, and this God is sufficient.

40. We may also hold that this supreme substance, which is unique, universal and necessary, nothing outside of it being independent of it,—this substance, which is a pure sequence of possible being, must be illimitable and must contain as much reality as is possible.

41. Whence it follows that God is absolutely perfect; for perfection is nothing but amount of positive reality, in the strict sense, leaving out of account the limits or bounds in things which are limited. And where there are no bounds, that is to say in God, perfection is absolutely infinite. (Theod. 22, Pref. [E. 469 a; G. vi. 27] .)

42. It follows also that created beings derive their perfections from the influence of God, but that their imperfections come

from their own nature, which is incapable of being without limits. For it is in this that they differ from God. An instance of this original imperfection of created beings may be seen in the natural inertia of bodies. (Theod. 20, 27-30, 153, 167, 377 sqq.)

43. It is farther true that in God there is not only the source of existences but also that of essences, in so far as they are real, that is to say, the source of what is real in the possible. For the understanding of God is the region of eternal truths or of the ideas on which they depend, and without Him there would be nothing real in the possibilities of things, and not only would there be nothing in existence, but nothing would even be possible. (Theod. 20.)

44. For if there is a reality in essences or possibilities, or rather in eternal truths, this reality must needs be founded in something existing and actual, and consequently in the existence of the necessary Being, in whom essence involves existence, or in whom to be possible is to be actual. (Theod. 184-189, 335.)

45. Thus God alone (or the necessary Being) has this prerogative that He must necessarily exist, if He is possible. And as nothing can interfere with the possibility of that which involves no limits, no negation and consequently no contradiction, this [His possibility] is sufficient of itself to make known the existence of God a priori. We have thus proved it, through the reality of eternal truths. But a little while ago we proved it also a posteriori, since there exist contingent beings, which can have

their final or sufficient reason only in the necessary Being, which has the reason of its existence in itself.

46. We must not, however, imagine, as some do, that eternal truths, being dependent on God, are arbitrary and depend on His will, as Descartes, and afterwards M. Poiret, appear to have held. That is true only of contingent truths, of which the principle is fitness (convenance) or choice of the best, whereas necessary truths depend solely on His understanding and are its inner object. (Theod. 180-184, 185, 335, 351, 380.)

47. Thus God alone is the primary unity or original simple substance, of which all created or derivative Monads are products and have their birth, so to speak, through continual fulgurations of the Divinity from moment to moment, limited by the receptivity of the created being, of whose essence it is to have limits. (Theod. 382-391, 398, 395.)

48. In God there is Power, which is the source of all, also Knowledge, whose content is the variety of the ideas, and finally Will, which makes changes or products according to the principle of the best. (Theod. 7, 149, 150.) These characteristics correspond to what in the created Monads forms the ground or basis, to the faculty of Perception and to the faculty of Appetition. But in God these attributes are absolutely infinite or perfect; and in the created Monads or the Entelechies (or perfectihabiae, as Hermolaus Barbarus translated the word)

there are only imitations of these attributes, according to the degree of perfection of the Monad. (Theod. 87.)

49. A created thing is said to act outwardly in so far as it has perfection, and to suffer [or be passive, patir] in relation to another, in so far as it is imperfect. Thus activity [action] is attributed to a Monad, in so far as it has distinct perceptions, and passivity [passion] in so far as its perceptions are confused. (Theod. 32, 66, 386.)

50. And one created thing is more perfect than another, in this, that there is found in the more perfect that which serves to explain a priori what takes place in the less perfect, and it is on this account that the former is said to act upon the latter.

51. But in simple substances the influence of one Monad upon another is only ideal, and it can have its effect only through the mediation of God, in so far as in the ideas of God any Monad rightly claims that God, in regulating the others from the beginning of things, should have regard to it. For since one created Monad cannot have any physical influence upon the inner being of another, it is only by this means that the one can be dependent upon the other. (Theod. 9, 54, 65, 66, 201. Abrege, Object. 3.)

52. Accordingly, among created things, activities and passivities are mutual. For God, comparing two simple substances, finds in each reasons which oblige Him to adapt the other to it, and

consequently what is active in certain respects is passive from another point of view; active in so far as what we distinctly know in it serves to explain (rendre raison de) what takes place in another, and passive in so far as the explanation [raison] of what takes place in it is to be found in that which is distinctly known in another. (Theod. 66.)

53. Now, as in the Ideas of God there is an infinite number of possible universes, and as only one of them can be actual, there must be a sufficient reason for the choice of God, which leads Him to decide upon one rather than another. (Theod. 8, 10, 44, 173, 196 sqq., 225, 414-416.)

54. And this reason can be found only in the fitness [convenance] , or in the degrees of perfection, that these worlds possess, since each possible thing has the right to aspire to existence in proportion to the amount of perfection it contains in germ. (Theod. 74, 167, 350, 201, 130, 352, 345 sqq., 354.)

55. Thus the actual existence of the best that wisdom makes known to God is due to this, that His goodness makes Him choose it, and His power makes Him produce it. (Theod. 8, 78, 80, 84, 119, 204, 206, 208. Abrege, Object. 1 and 8.)

56. Now this connexion or adaptation of all created things to each and of each to all, means that each simple substance has relations which express all the others, and, consequently, that it is a perpetual living mirror of the universe. (Theod. 130, 360.)

57. And as the same town, looked at from various sides, appears quite different and becomes as it were numerous in aspects (perspectivement); even so, as a result of the infinite number of simple substances, it is as if there were so many different universes, which, nevertheless are nothing but aspects [perspectives] of a single universe, according to the special point of view of each Monad. (Theod. 147.)

58. And by this means there is obtained as great variety as possible, along with the greatest possible order; that is to say, it is the way to get as much perfection as possible. (Theod. 120, 124, 241 sqq., 214, 243, 275.)

59. Besides, no hypothesis but this (which I venture to call proved) fittingly exalts the greatness of God; and this Monsieur Bayle recognized when, in his Dictionary (article Rorarius), he raised objections to it, in which indeed he was inclined to think that I was attributing too much to God —more than it is possible to attribute. But he was unable to give any reason which could show the impossibility of this universal harmony, according to which every substance exactly expresses all others through the relations it has with them.

60. Further, in what I have just said there may be seen the reasons a priori why things could not be otherwise than they are. For God in regulating the whole has had regard to each part, and in particular to each Monad, whose nature being to

represent, nothing can confine it to the representing of only one part of things; though it is true that this representation is merely confused as regards the variety of particular things [le detail] in the whole universe, and can be distinct only as regards a small part of things, namely, those which are either nearest or greatest in relation to each of the Monads; otherwise each Monad would be a deity. It is not as regards their object, but as regards the different ways in which they have knowledge of their object, that the Monads are limited. In a confused way they all strive after [vont a] the infinite, the whole; but they are limited and differentiated through the degrees of their distinct perceptions.

61. And compounds are in this respect analogous with [symbolisent avec] simple substances. For all is a plenum (and thus all matter is connected together) and in the plenum every motion has an effect upon distant bodies in proportion to their distance, so that each body not only is affected by those which are in contact with it and in some way feels the effect of everything that happens to them, but also is mediately affected by bodies adjoining those with which it itself is in immediate contact. Wherefore it follows that this inter-communication of things extends to any distance, however great. And consequently everybody feels the effect of all that takes place in the universe, so that he who sees all might read in each what is happening everywhere, and even what has happened or shall happen, observing in the present that which is far off as well in time as

in place: sympnoia panta, as Hippocrates said. But a soul can read in itself only that which is there represented distinctly; it cannot all at once unroll everything that is enfolded in it, for its complexity is infinite.

62. Thus, although each created Monad represents the whole universe, it represents more distinctly the body which specially pertains to it, and of which it is the entelechy; and as this body expresses the whole universe through the connexion of all matter in the plenum, the soul also represents the whole universe in representing this body, which belongs to it in a special way. (Theod. 400.)

63. The body belonging to a Monad (which is its entelechy or its soul) constitutes along with the entelechy what may be called a living being, and along with the soul what is called an animal. Now this body of living being or of an animal is always organic; for, as every Monad is, in its own way, a mirror of the universe, and as the universe is ruled according to a perfect order, there must also be order in that which represents it, i.e. in the perceptions of the soul, and consequently there must be order in the body, through which the universe is represented in the soul. (Theod. 403.)

64. Thus the organic body of each living being is a kind of divine machine or natural automaton, which infinitely surpasses all artificial automata. For a machine made by the skill of man is not a machine in each of its parts. For instance, the tooth of a

brass wheel has parts or fragments which for us are not artificial products, and which do not have the special characteristics of the machine, for they give no indication of the use for which the wheel was intended. But the machines of nature, namely, living bodies, are still machines in their smallest parts ad infinitum. It is this that constitutes the difference between nature and art, that is to say, between the divine art and ours. (Theod. 134, 146, 194, 403.)

65. And the Author of nature has been able to employ this divine and infinitely wonderful power of art, because each portion of matter is not only infinitely divisible, as the ancients observed, but is also actually subdivided without end, each part into further parts, of which each has some motion of its own; otherwise it would be impossible for each portion of matter to express the whole universe. (Theod. Prelim., Disc. de la Conform. 70, and 195.)

66. Whence it appears that in the smallest particle of matter there is a world of creatures, living beings, animals, entelechies, souls.

67. Each portion of matter may be conceived as like a garden full of plants and like a pond full of fishes. But each branch of every plant, each member of every animal, each drop of its liquid parts is also some such garden or pond.

68. And though the earth and the air which are between the plants of the garden, or the water which is between the fish of the pond, be neither plant nor fish; yet they also contain plants and fishes, but mostly so minute as to be imperceptible to us.

69. Thus there is nothing fallow, nothing sterile, nothing dead in the universe, no chaos, no confusion save in appearance, somewhat as it might appear to be in a pond at a distance, in which one would see a confused movement and, as it were, a swarming of fish in the pond, without separately distinguishing the fish themselves. (Theod. Pref. [E. 475 b; 477 b; G. vi. 40, 44] .)

70. Hence it appears that each living body has a dominant entelechy, which in an animal is the soul; but the members of this living body are full of other living beings, plants, animals, each of which has also its dominant entelechy or soul.

71. But it must not be imagined, as has been done by some who have misunderstood my thought, that each soul has a quantity or portion of matter belonging exclusively to itself or attached to it for ever, and that it consequently owns other inferior living beings, which are devoted for ever to its service. For all bodies are in a perpetual flux like rivers, and parts are entering into them and passing out of them continually.

72. Thus the soul changes its body only by degrees, little by little, so that it is never all at once deprived of all its organs;

and there is often metamorphosis in animals, but never metempsychosis or transmigration of souls; nor are there souls entirely separate [from bodies] nor unembodied spirits [genies sans corps] . God alone is completely without body. (Theod. 90, 124.)

73. It also follows from this that there never is absolute birth [generation] nor complete death, in the strict sense, consisting in the separation of the soul from the body. What we call births [generations] are developments and growths, while what we call deaths are envelopments and diminutions.

74. Philosophers have been much perplexed about the origin of forms, entelechies, or souls; but nowadays it has become known, through careful studies of plants, insects, and animals, that the organic bodies of nature are never products of chaos or putrefaction, but always come from seeds, in which there was undoubtedly some preformation; and it is held that not only the organic body was already there before conception, but also a soul in this body, and, in short, the animal itself; and that by means of conception this animal has merely been prepared for the great transformation involved in its becoming an animal of another kind. Something like this is indeed seen apart from birth [generation] , as when worms become flies and caterpillars become butterflies. (Theod. 86, 89. Pref. [E. 475 b; G. vi. 40 sqq.] ; 90, 187, 188, 403, 86, 397.)

75. The animals, of which some are raised by means of conception to the rank of larger animals, may be called spermatic, but those among them which are not so raised but remain in their own kind (that is, the majority) are born, multiply, and are destroyed like the large animals, and it is only a few chosen ones [elus] that pass to a greater theatre.

76. But this is only half of the truth, and accordingly I hold that if an animal never comes into being by natural means [naturellement] , no more does it come to an end by natural means; and that not only will there be no birth [generation] , but also no complete destruction or death in the strict sense. And these reasoning's, made a posteriori and drawn from experience are in perfect agreement with my principles deduced a priori, as above. (Theod. 90.)

77. Thus it may be said that not only the soul (mirror of an indestructible universe) is indestructible, but also the animal itself, though its mechanism [machine] may often perish in part and take off or put on an organic slough [des depouilles organiques] .

78. These principles have given me a way of explaining naturally the union or rather the mutual agreement [conformite] of the soul and the organic body. The soul follows its own laws, and the body likewise follows its own laws; and they agree with each other in virtue of the pre-established harmony between all substances, since they are all

representations of one and the same universe. (Pref. [E. 475 a; G. vi. 39] ; Theod. 340, 352, 353, 358.)

79. Souls act according to the laws of final causes through appetitions, ends, and means. Bodies act according to the laws of efficient causes or motions. And the two realms, that of efficient causes and that of final causes, are in harmony with one another.

80. Descartes recognized that souls cannot impart any force to bodies, because there is always the same quantity of force in matter. Nevertheless he was of opinion that the soul could change the direction of bodies. But that is because in his time it was not known that there is a law of nature which affirms also the conservation of the same total direction in matter. Had Descartes noticed this he would have come upon my system of pre-established harmony. (Pref. [E. 477 a; G. vi. 44] ; Theod. 22, 59, 60, 61, 63, 66, 345, 346 sqq., 354, 355.)

81. According to this system bodies act as if (to suppose the impossible) there were no souls, and souls act as if there were no bodies, and both act as if each influenced the other.

82. As regards minds [esprits] or rational souls, though I find that what I have just been saying is true of all living beings and animals (namely that animals and souls come into being when the world begins and no more come to an end that the world does), yet there is this peculiarity in rational animals, that their spermatic animalcules, so long as they are only spermatic, have

merely ordinary or sensuous [sensitive] souls; but when those which are chosen [elus] , so to speak, attain to human nature through an actual conception, their sensuous souls are raised to the rank of reason and to the prerogative of minds [esprits] . (Theod. 91, 397.)

83. Among other differences which exist between ordinary souls and minds [esprits] , some of which differences I have already noted, there is also this: that souls in general are living mirrors or images of the universe of created things, but that minds are also images of the Deity or Author of nature Himself, capable of knowing the system of the universe, and to some extent of imitating it through architectonic ensamples [echantillons] , each mind being like a small divinity in its own sphere. (Theod. 147.)

84. It is this that enables spirits [or minds —esprits] to enter into a kind of fellowship with God, and brings it about that in relation to them He is not only what an inventor is to his machine (which is the relation of God to other created things), but also what a prince is to his subjects, and, indeed, what a father is to his children.

85. Whence it is easy to conclude that the totality [assemblage] of all spirits [esprits] must compose the City of God, that is to say, the most perfect State that is possible,

under the most perfect of Monarchs. (Theod. 146; Abrege, Object. 2.)

86. This City of God, this truly universal monarchy, is a moral world in the natural world, and is the most exalted and most divine among the works of God; and it is in it that the glory of God really consists, for He would have no glory were not His greatness and His goodness known and admired by spirits [esprits] . It is also in relation to this divine City that God specially has goodness, while His wisdom and His power are manifested everywhere. (Theod. 146; Abrege, Object. 2.)

87. As we have shown above that there is a perfect harmony between the two realms in nature, one of efficient, and the other of final causes, we should here notice also another harmony between the physical realm of nature and the moral realm of grace, that is to say, between God, considered as Architect of the mechanism [machine] of the universe and God considered as Monarch of the divine City of spirits [esprits] . (Theod. 62, 74, 118, 248, 112, 130, 247.)

88. A result of this harmony is that things lead to grace by the very ways of nature, and that this globe, for instance, must be destroyed and renewed by natural means at the very time when the government of spirits requires it, for the punishment of some and the reward of others. (Theod. 18 sqq., 110, 244, 245, 340.)

89. It may also be said that God as Architect satisfies in all respects God as Lawgiver, and thus that sins must bear their penalty with them, through the order of nature, and even in virtue of the mechanical structure of things; and similarly that noble actions will attain their rewards by ways which, on the bodily side, are mechanical, although this cannot and ought not always to happen immediately.

90. Finally, under this perfect government no good action would be unrewarded and no bad one unpunished, and all should issue in the well-being of the good, that is to say, of those who are not malcontents in this great state, but who trust in Providence, after having done their duty, and who love and imitate, as is meet, the Author of all good, finding pleasure in the contemplation of His perfections, as is the way of genuine 'pure love,' which takes pleasure in the happiness of the beloved. This it is which leads wise and virtuous people to devote their energies to everything which appears in harmony with the presumptive or antecedent will of God, and yet makes them content with what God actually brings to pass by His secret, consequent and positive [decisive] will, recognizing that if we could sufficiently understand the order of the universe, we should find that it exceeds all the desires of the wisest men, and that it is impossible to make it better than it is, not only as a whole and in general but also for ourselves in particular, if we are attached, as we ought to be, to the Author of all, not only as to the architect and efficient cause of our being, but as to our

master and to the final cause, which ought to be the whole aim of our will, and which can alone make our happiness. (Theod. 134, 278. Pref. [E. 469; G. vi. 27, 28] .)

Leibniz the Mathematician

In his Essay Explication de l'Arithmétique Binaire, Leibniz introduces the binary system is the simplest possible notation for numerals. Our ordinary decimal system has a choice of ten characters for each place. In the binary system there are only two characters: one to designate an empty place (0), the other to mark that it is filled (1).
The Binary code system made it possible for computers and any digital technology to exist.

Leibniz was the first to see that the coefficients of a system of linear equations could be arranged into an array, now called a matrix, which can be manipulated to find the solution of the system.
This method was later called Gaussian elimination. Leibniz discoveries of Boolean algebra and of symbolic logic made him a pioneer in this field and opened the doors for greater achievements.

By far Leibniz most important mathematical achievement was his discovery of the ***Infinitesimal Calculus***, which he made in 1675, at the end of his Paris period.
Newton beat Leibniz by almost nine years, but Leibniz was the one to publish his discovery first, in 1684.

The invention of the calculus marks a new era and the starting point of the modern mathematics. Even when Newton' s method of fluxions was published, it was by no means obvious that it was essentially the same as Leibniz' s infinitesimal calculus.

Each Leibniz and Newtown's had different approach in their calculus. The first used geometrical approach with strange notions and jargons, the latter used an algebraic approach and his language was more appropriate and incorporated terms such integrals and coordinates which we still use to this day.

Leibniz was credited along with Newton with the invention of infinitesimal calculus (that comprises differential and integral

calculus).

According to Leibniz' s notebooks, a critical breakthrough occurred on November 1675, when he employed integral calculus for the first time to find the area under the graph of a function $y = f(x)$. He introduced several notations used to this day, for instance the integral sign $\int$ representing an elongated S, from the Latin word summa and the d used for differentials, from the Latin word differentia.

This cleverly suggestive notation for the calculus is probably his most enduring mathematical legacy. Leibniz did not publish anything about his calculus until 1684. The product rule of differential calculus is still called " **Leibniz' s Law**" . In addition, the theorem that tells how and when to differentiate under the integral sign is called the Leibniz integral rule.

Leibniz exploited infinitesimals in developing the calculus, manipulating them in ways suggesting that they had paradoxical algebraic properties.

George Berkeley openly criticized these principles, though recent studies argues that Leibnizian calculus was free of contradictions, and was better grounded than Berkeley' s empiricist criticisms.

Beginning in 1960, Abraham Robinson worked out a rigorous foundation for Leibniz' s infinitesimals, using model theory, in the context of a field of Hyperreal numbers.

The resulting non-standard analysis can be seen as a belated vindication of Leibniz' s mathematical reasoning. Robinson' s

transfer principle is a mathematical implementation of Leibniz' s heuristic law of continuity, while the standard part function implements the Leibnizian transcendental law of homogeneity.

Calculus Paradox

While Newton considered variables changing with time and used quantities x' and y' which were finite velocities, to compute the tangent, Leibniz however thought of the variables x and y as ranging over sequences of infinitely close values. He introduced ∂x and ∂y as differences between successive values of these sequences. Leibniz knew that $\partial y/\partial x$ gives the tangent but he did not use it as a defining property.

It is clear to say, that for Newton the calculus was geometrical while for Leibniz it was Algebraic and analytic.

Leibniz took a great importance for the use of his notation and put a lot of thought into the symbols he used. Newton, on the other hand, didn't bother too much into that. As a result to that, the notation that is used in Calculus today is owing to Leibniz.

It was when using Leibniz calculus, the paradoxes of Zeno of Elea could be also resolved, when the seemingly moving body's correlated position and time values are fractionally dichotomized in the paradoxes, an infinite deterioration can then be mathematically persuaded, the idea of motion and physical continuity shown to yield contradiction, as such values are not representative of times at which a body is in that specific precise position, but rather, at which it is *passing* through them.

Calculus wasn't born out of thin air, but as a timeline of humanity advancement. Archimedes, in 225 BC, made one of

the most noteworthy contributions which was to show that the area of a segment of a parabola is $^4/_3$ the area of a triangle with the same base and vertex and $^2/_3$ of the area of the circumscribed parallelogram.

He did construct an infinite sequence of triangles starting with one of area A and continually adding further triangles between the existing ones and the parabola to get areas

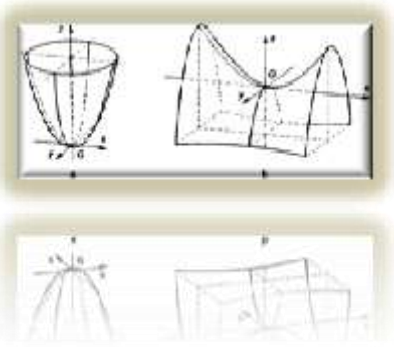
$$A,\ A + A/4\ ,\ A + A/4 + A/16\ ,\ A + A/4 + A/16 + A/64\ , \ldots$$

The area of the segment of the parabola is therefore

$$A(1 + {}^1/_4 + {}^1/_4{}^2 + {}^1/_4{}^3 + \ldots.) = ({}^4/_3)A.$$

This method was used to find an approximation to the area of a circle.

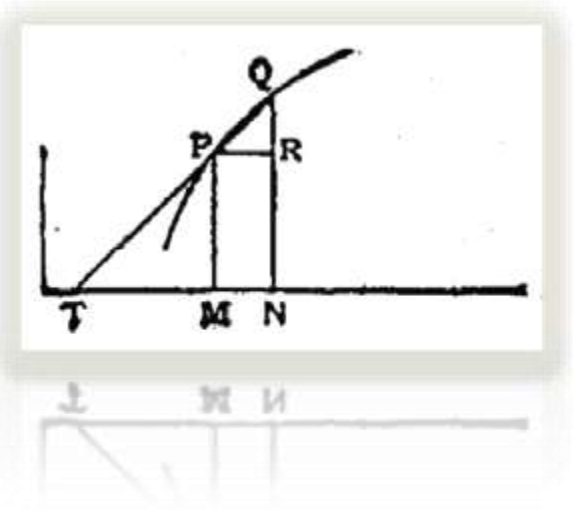
Archimedes worked as well on the volume and surface area of a sphere, the volume and area of a cone, the volume of any segment of a paraboloid and a segment of a hyperboloid.



No progress was made for a great length of time, many great mathematicians made great contributions like *Euler, Valerio, Kepler and Fermat.*

But it was *René Descartes* who produced an important method of determining normals in his *La Géométrie* in 1637 based on double intersection.
Descartes was a major influence on *Newton; Huygens* was a major influence on *Leibniz* and played a considerable part in producing a more satisfactory method to the calculus.

The next major step was provided by *Torricelli and Barrow.* *Barrow* gave a method of tangents to a curve where the tangent is given as the limit of a chord as the points approach each other known as Barrow' s differential triangle.



Both Torricelli and Barrow considered the problem of motion with variable speed. The derivative of the distance is velocity and the inverse operation takes one from the velocity to the distance.
In 1666 Newton wrote the unpublished on tract on fluxions which had a major influence on the direction the calculus was to take.

He thought of a particle tracing out a curve with two moving lines which were the coordinates. The horizontal velocity x' and the vertical velocity y' were the fluxions of x and y associated with the flux of time, he used what he called fluents.

The slope of the tangent was given for each x and when $y' / x' = f(x)$ then Newton solves the problem by antidifferentiation. He also calculated areas by antidifferentiation and this work contains the first clear statement of the Fundamental Theorem of the Calculus.

Leibniz's ideas about calculus were resulting from close analogies with finite sums and differences. Leibniz also formulated an early statement of the Fundamental Theorem of Calculus, and then later in a 1693 Leibniz stated, " The general problem of quadrature's can be reduced to the finding of a curve that has a given law of tangency.

After he studied the relationship between difference sequences and sums, and then an infinitesimal version helped suggest to him the essential features of the calculus.
Leibniz studied this phenomenon further in his beautiful harmonic triangle, making him acutely aware that forming

difference sequences and sums of sequences are mutually inverse operations.
He used an analogy to think of the problem of an area as a summation of infinitesimal differences, leading him to the linking between ***area*** and ***tangent***.
It is fair to say that we can unmistakably see Huygens shadow on many of Leibniz Mathematical ideas and theories.

Leibniz worked towards a grand plan and definitely calculus wasn't final destination . . .

As George M Ross wrote; "It is beyond reasonable doubt that Leibniz' s discovery was in fact independent, but the nationalistic fervour aroused by the dispute, and the incontrovertible evidence in favour of Newton's priority, had disastrous consequences for English mathematics. While the Continental mathematicians of the eighteenth century made great strides in the theory of the calculus, and in its applications to Newtonian physics, the English stuck loyally to Newton' s own much less suitable method of fluxions, and remained in a backwater for over a century".

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Music is a hidden arithmetic exercise of the soul, which does not know that it is counting. *Letter to Christian Goldbach, 1712.*

" Nothing can be taught us of which we have not already in our minds the idea. This idea is as it were the material out of which the thought will form itself." *Discourse on Metaphysics, 1686.*

" Happiness consists in the most harmonious state of mind. The nature of the mind is to think; therefore, the harmony of the mind consists in thinking about harmony; and the greatest harmony of the mind or happiness consists in the concentration of the universal harmony, i.e., of God, in the mind." *Confessio Philosophi, 1671–1678.*